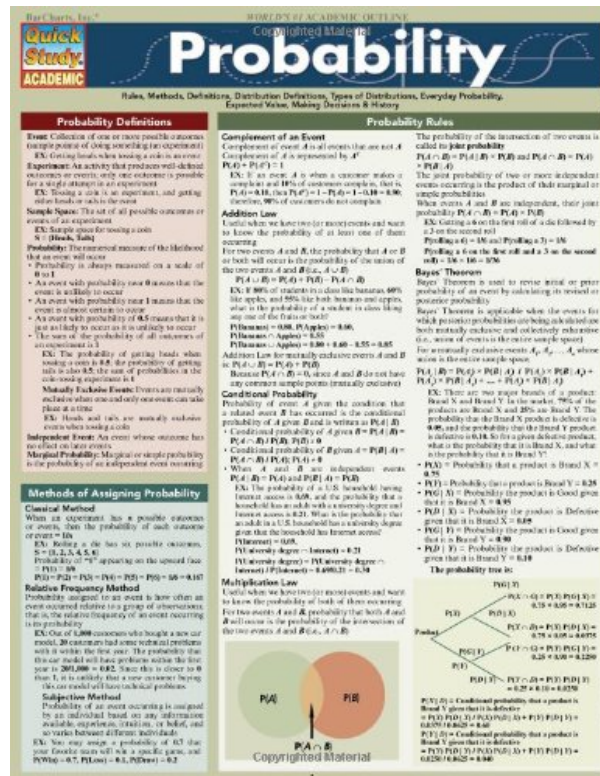


PROBABILITY QUICK STUDY REFERENCE OUTLINE BY RAVI BEHARA



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Rules, Methods, Definitions, Distribution Definitions, Types of Distributions, Everyday Probability, Expected Value, Making Decisions & History

Probability Definitions

Event: Collection of one or more possible outcomes (simple points of doing something in an experiment)
EX: Getting heads when tossing a coin is an event.
Experiment: An activity that produces well-defined outcomes as events; only one outcome is possible for a single attempt in an experiment.
EX: Tossing a coin is an experiment, and getting either heads or tails is the event.
Sample Space: The set of all possible outcomes or events of an experiment.
EX: Sample space for tossing a coin
 $S = \{ \text{Heads, Tails} \}$
Probability: The numerical measure of the likelihood that an event will occur.

- Probability is always measured on a scale of 0 to 1.
- An event with probability near 0 means that the event is unlikely to occur.
- An event with probability near 1 means that the event is almost certain to occur.
- An event with probability of 0.5 means that it is just as likely to occur as it is unlikely to occur.
- The sum of the probability of all outcomes of an experiment is 1.

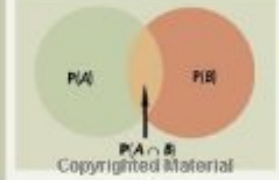
EX: The probability of getting heads when tossing a coin is 0.5; the probability of getting tails is also 0.5; the sum of probabilities in the coin-tossing experiment is 1.
Mutually Exclusive Events: Events are mutually exclusive when one and only one event can take place at a time.
EX: Heads and tails are mutually exclusive events when tossing a coin.
Independent Events: An event whose outcome has no effect on later events.
Marginal Probability: Marginal or simple probability is the probability of an independent event occurring.

Methods of Assigning Probability

Classical Method
 When an experiment has a possible outcome or events, then the probability of each outcome or event is $1/n$.
EX: Rolling a die has six possible outcomes, $S = \{ 1, 2, 3, 4, 5, 6 \}$
 Probability of "4" appearing on the upward face.
 $P(4) = 1/6$
 $P(1) = P(2) = P(3) = P(4) = P(5) = P(6) = 1/6 = 0.167$
Relative Frequency Method
 Probability assigned to an event is how often an event occurred relative to a group of observations; that is, the relative frequency of an event occurring in its probability.
EX: Out of 1,000 customers who bought a new car model, 200 customers had some technical problems with it within the first year. The probability that this car model will have problems within the first year is $200/1000 = 0.2$. Since this is closer to 0 than 1, it is unlikely that a new customer buying this car model will have technical problems.
Subjective Method
 Probability of an event occurring is assigned by an individual based on any information available: experience, intuition, or belief, and so varies between different individuals.
EX: You may assign a probability of 0.7 that your favorite team will win a specific game, and $P(\text{Win}) = 0.7$, $P(\text{Loss}) = 0.3$, $P(\text{Draw}) = 0.2$

Probability Rules

Complement of an Event
 Complement of event A is all events that are not A.
 Complement of A is represented by A^c
 $P(A^c) = P(A') = 1 - P(A)$
EX: If an event A is when a customer makes a complaint and 10% of customers complain, that is, $P(A) = 0.10$, then $P(A^c) = 1 - P(A) = 1 - 0.10 = 0.90$; therefore, 90% of customers do not complain.
Addition Law
 Useful when we have two (or more) events and want to know the probability of at least one of them occurring.
 For two events A and B, the probability that A or B or both will occur is the probability of the union of the two events A and B (i.e., $A \cup B$).
 $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
EX: If 80% of students in a class like bananas, 60% like apples, and 50% like both bananas and apples, what is the probability of a student liking any one of the fruits or both?
 $P(\text{Bananas}) = 0.80$, $P(\text{Apples}) = 0.60$
 $P(\text{Bananas} \cap \text{Apples}) = 0.50$
 $P(\text{Bananas} \cup \text{Apples}) = 0.80 + 0.60 - 0.50 = 0.90$
 Addition Law for mutually exclusive events A and B is $P(A \cup B) = P(A) + P(B)$
 Because $P(A \cap B) = 0$, since A and B do not have any common simple points (mutually exclusive).
Conditional Probability
 Probability of event A given the condition that a related event B has occurred is the conditional probability of A given B and is written as $P(A|B)$.
 • Conditional probability of A given B = $P(A|B) = P(A \cap B) / P(B)$, $P(B) > 0$
 • Conditional probability of B given A = $P(B|A) = P(A \cap B) / P(A)$, $P(A) > 0$
 • When A and B are independent events $P(A|B) = P(A)$ and $P(B|A) = P(B)$
EX: The probability of a U.S. household having Internet access is 0.60, and the probability that a household has an adult with a university degree and Internet access is 0.21. What is the probability that an adult in a U.S. household has a university degree given that the household has Internet access?
 $P(\text{Internet}) = 0.60$
 $P(\text{University degree} \cap \text{Internet}) = 0.21$
 $P(\text{University degree} | \text{Internet}) = P(\text{University degree} \cap \text{Internet}) / P(\text{Internet}) = 0.21 / 0.60 = 0.35$



The probability of the intersection of two events is called **joint probability**.
 $P(A \cap B) = P(A|B) \cdot P(B)$ and $P(A \cap B) = P(B|A) \cdot P(A)$
 The joint probability of two or more independent events occurring is the product of their marginal or simple probabilities.
 When events A and B are independent, their joint probability $P(A \cap B) = P(A) \cdot P(B)$
EX: Getting a 6 on the first roll of a die followed by a 2 on the second roll.
 $P(\text{Rolling a 6}) = 1/6$ and $P(\text{Rolling a 2}) = 1/6$
 $P(\text{Rolling a 6 on the first roll and a 2 on the second roll}) = 1/6 \cdot 1/6 = 1/36$

Bayes' Theorem

Bayes' Theorem is used to revise initial or prior probability of an event by calculating its revised or posterior probability.
 Bayes' Theorem is applicable when the events for which posterior probabilities are being calculated are both mutually exclusive and collectively exhaustive (i.e., union of events is the entire sample space).
 For a mutually exclusive events A_1, A_2, \dots, A_n whose union is the entire sample space,
 $P(A|B) = P(A) \cdot P(B|A) / (P(A_1) \cdot P(B|A_1) + P(A_2) \cdot P(B|A_2) + \dots + P(A_n) \cdot P(B|A_n))$
EX: There are two major brands of a product: Brand X and Brand Y. In the market, 70% of the products are Brand X and 30% are Brand Y. The probability that the Brand X product is defective is 0.05, and the probability that the Brand Y product is defective is 0.10. So for a given defective product, what is the probability that it is Brand X, and what is the probability that it is Brand Y?

- $P(X) =$ Probability that a product is Brand X = 0.70
- $P(Y) =$ Probability that a product is Brand Y = 0.30
- $P(D|X) =$ Probability the product is Defective given that it is Brand X = 0.05
- $P(D|Y) =$ Probability the product is Defective given that it is Brand Y = 0.10

 The probability tree is:



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